Acta clin Croat 2001; 40:191-195 Professsional Paper

CORRELATION BETWEEN GLASGOW COMA SCALE SCORE AND INTRACRANIAL PRESSURE IN PATIENTS WITH SEVERE HEAD INJURY

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SUMMARY – Patients sustaining severe head injury require use of standardized treatment protocols, most of them focused on the maintenance of cerebral perfusion pressure. Among other goals, neurologic recovery can be expected if a satisfactory level of cerebral perfusion pressure has been achieved. The aim of the study was to assess the correlation between neurologic findings expressed as Glasgow Coma Scale (GCS) score, and intracranial cerebral perfusion and mean arterial pressure. Results obtained in 24 study patients pointed to negative correlation between GCS score and intracranial pressure (p=0.006), and positive correlation between GCS score and cerebral perfusion pressure (p=0.016). There was no statistically significant correlation between GCS score and mean arterial pressure, which could be explained by use of iatrogenic procedures for the maintenance of mean arterial pressure. In conclusion, the intracranial and cerebral perfusion pressures appear to correlate well with GCS score, thus monitoring of these pressures may be highly useful in the follow-up of patients with severe brain injury.

Key words: *Brain injuries, therapy; Monitoring, physiologic; Intracranial pressure, physiology*

Introduction

Severe head trauma and consecutive brain injury are as hardly predictable in the pathophysiological course as at the moment of injury and in the early posttraumatic period[1]. Hemorrhage, most often subdural and epidural, with elements of subarachnoidal hemorrhage are the precipitating factors of elevated intracranial pressure (ICP). Brain edema is a consecutive pathologic effect and is detectable in the early hours after trauma. All this leads to deterioration of the neurologic status. Time course of the clinical status is an elementary request in the protocols for severe head injury. This is supplemented with ICP monitoring and in recent time with sophisticated methods of tissue oxygen, lactate and pH monitoring[2]. Also, electrical activity of the brain can be monitored, and all this information can be integrated in the multimodal monitoring systems[2,3].

The aim of the study was to assess the possible correlation of ICP, cerebral perfusion pressure (CPP) and mean arterial pressure (MAP) with clinical status.

Patients and Methods

The study was designed as an observational investigation. Inclusion criteria were Glasgow Coma Scale (GCS) score ≤8 and inserted catheter for ICP monitoring. Excluded were patients with GCS score 3 after resuscitation, and dilated, areactive pupils, and those in whom data for more than 24 hours were missing. During 18 months, 30 patients with severe head injuries were treated and moni-

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Received May 28, 2001, accepted in revised form July 20, 2001

tored at our Neurosurgical Intensive Care Unit (NICU). Twenty-four of them met the criteria and were enrolled in the study, with median of monitoring duration of 3 (1-7) days.

Standard interventions were performed, e.g., radial artery cannulation, central venous access, and internal jugular vein bulb cannulation. All therapeutic interventions were performed in accordance with the Brain Trauma Foundation guidelines[4]. ICP monitoring was performed *via* ventriculostomy, thereby employing commercial kits (Codman External Drainage System II, Johnson & Johnson, Bracknell, UK). The procedure was carried out at bedside or in the operating theater as part of extensive neurosurgical procedures (evacuation of subdural or epidural hematomas, decompressive craniotomy).

The following variables were monitored: ICP, MAP, CPP and GCS. All pressures were monitored invasively and with identical transducers (Becton Dickinson Critical Care Systems, Sandy, Utah, USA) connected to monitors (Datex Engstrom CS/3, Datex-Ohmeda Instrumentarium Corp., Helsinki, Finland), and expressed numerically in mm Hg. Measurements were always performed at 8.00 a.m. At the same time, patients were neurologically examined and these data were expressed as GCS score. All data were recorded in the patient's sheet and entered in database. Kendall Tau nonparametric correlation was calculated by use of a commercial software package available.

Results

There was no statistically significant sex difference in demographic data of the study patients (Table 1), except for the fact that men had more often sustained severe head injury. Median and range are shown for both male and female patients together (Table 2). The correlations between ICP and GCS (Fig. 1), CPP and GCS (Fig. 2), and MAP and GCS (Fig. 3) were assessed in survivors and nonsurvivors. In the group of nonsurvivors, a significant correlation was found between ICP and GCS (z=-2.351), and CPP and GCS (z=3.231), while no correlation was observed between MAP and GCS (z=1.287). There was no significant correlation in the group of survivors.

Discussion

In patients with severe head injury, ICP is elevated as the reflexion of pathophysiologic disturbances in the brain tissue. ICP monitoring allows for prompt intervention in the conditions of neurologic deterioration or elevated ICP. Most of the protocols for the management of severe head trauma are CPP targeted[5]. However, decreasing ICP is the most important therapeutic tool, and subsequent ventriculostomy is the gold standard for brain injured patients[6]. Cerebral perfusion can be improved by intravascular volume expansion or enhancement with inotropic drugs to elevate MAP[4].

Table 1. Patient demographic data

	Male	Female
n	20	5
Age (yrs)	57 (27-59)	44 (27-59)
Mortality rate (%)	45	40

Table 2. Descriptive statistics for monitored variables

	Median (mm Hg)	Range (mm Hg)
Mean arterial pressure	91	54-126
Intracranial pressure	15	3-52
Cerebral perfusion pressure	75	8-115
Glasgow Coma Scale score	6	3-11

Conclusion

The study produced the results as expected, although there was a lack of correlation between MAP and GCS. This could be explained by our efforts to improve cerebral perfusion by influencing MAP, mostly through volume expansion rather than inotropic drug activity. ICP and CPP correlated with the patient clinical status expressed as GCS. Monitoring of ICP was found to be a reliable tool in the management of severe head injury.

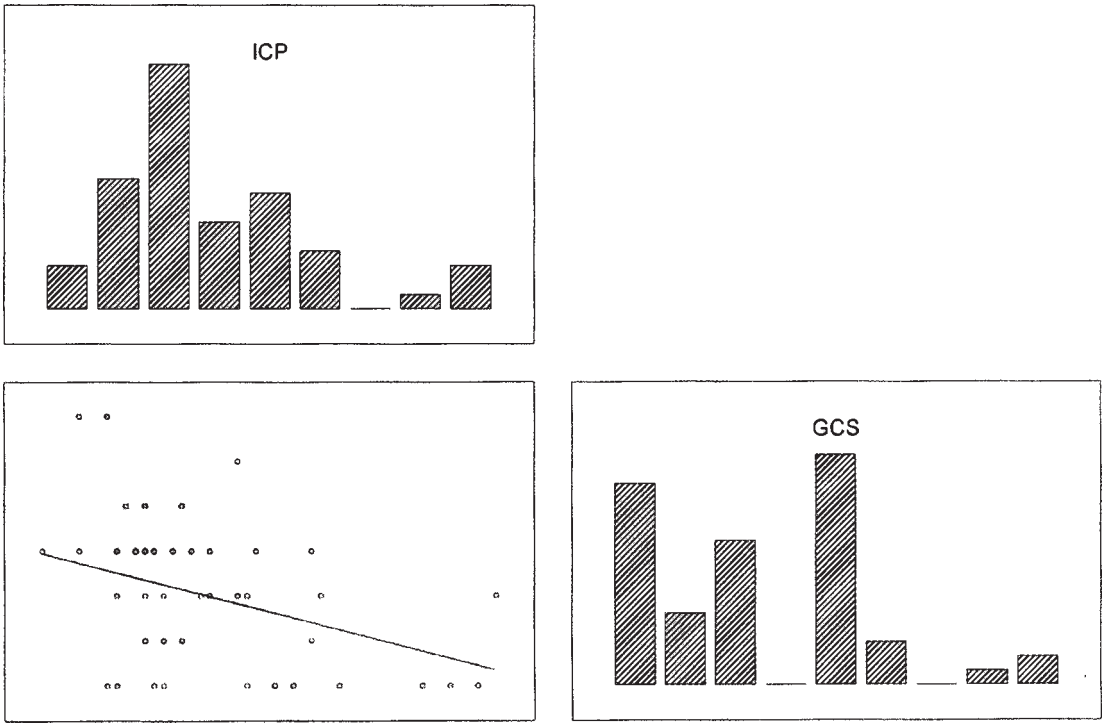

Fig. 1. Correlation between Glasgow Coma Scale score (GCS) and intracranial pressure (ICP) in nonsurvivors (p=0.01).

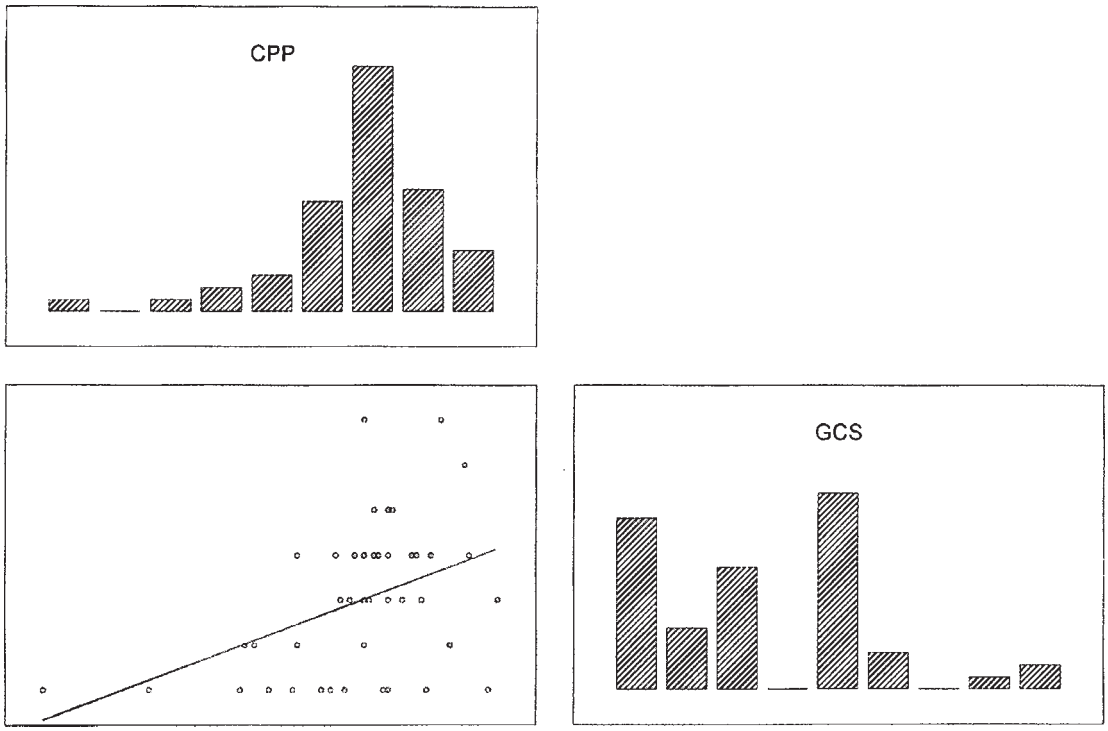

Fig. 2. Correlation between Glasgow Coma Scale score (GCS) and cerebral perfusion pressure (CPP) in nonsurvivors (p=0.001).

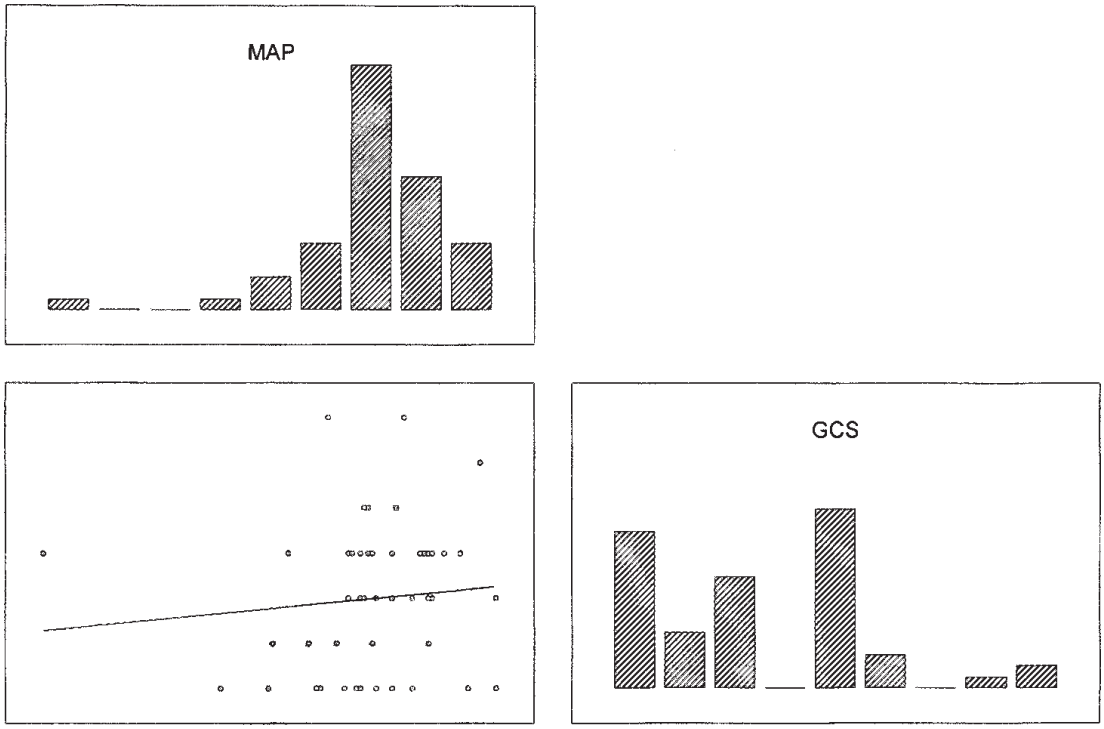

Fig. 3. Correlation between Glasgow Coma Scale score (GCS) and mean arterial pressure (MAP) (non-significant).

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Sažetak

KORELACIJA IZMEĐU ZBIRA GLASGOWSKE LJESTVICE ZA KOMU I INTRAKRANIJSKOG TLAKA U BOLESNIKA S TEŠKOM OZLJEDOM GLAVE

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U bolesnika s teškom ozljedom mozga neophodna je primjena standardiziranih protokola liječenja. Većina ih je usmjerena na održavanje cerebralnog perfuzijskog tlaka. Oporavak neurološkog statusa očekivan je ako se cerebralni perfuzijski tlak održava u zadovoljavajućim granicama. Cilj ispitivanja bio je odrediti povezanost neurološkog statusa izraženog kao zbir Glasgowske ljestvice za komu (GCS) s intrakranijskim cerebralnim perfuzijskim i srednjim arterijskim tlakom. Podaci skupljeni tijekom liječenja 24 bolesnika s teškom ozljedom mozga ukazali su na postojanje negativne korelacije zbira GCS i intrakranijskog tlaka (p=0,006) te pozitivne korelacije zbira GCS i cerebralnog perfuzijskog tlaka (p=0,016). Nije bilo statistički značajne korelacije između zbira GCS i srednjeg arterijskog tlaka, što se može tumačiti jatrogenim postupcima održavanja srednjeg arterijskog tlaka. Zaključeno je da su praćeni intrakranijski i cerebralni perfuzijski tlakovi dobro povezani sa zbirom GCS. Promatranje ovih tlakova pouzdan je način praćenja bolesnika s teškom ozljedom mozga.

Ključne riječi: *Ozljede mozga, terapija; Promatranje, fiziološko; Intrakranijski tlak, fiziologija*